ENVIRONMENTAL

Using Low Cost VOC Sensor Networks and Predicative Algorithms to Mitigate Pollution Risks to the Community

- 20% growth in Denver since 2010
- Denver housing prices have doubled since 2008
- Colorado 7th in the US for Oil Production
- 80% of that production is in the Denver-Julesburg Basin
- Colorado Senate Bill 181









"Erie approves 600 new homes close to future oil and gas development" -Denver Channel

"Drilling rigs and housing development face off in Colorado suburbs" - Denver Post

"Neighborhoods Worry About Living Amid Oil And Gas Development" - NPR

> "Deadly House Explosion in Colorado Traced to Uncapped Pipe From Gas Well" - LA Times







Low Cost VOC Sensor Networks

Why Low Cost VOC Sensor Networks?

- Commercially available
- Cover large areas, hyper local
- Prevent issues before they reach the community
- Done right could be good for community, cities, regulators and industry
- Done wrong bad data and lawsuits





Low Cost VOC Sensor Networks

Sensors

- Metal Oxide Sensors (MOX) total VOCs w/methane
- Photo-Ionization Detectors (PIDs) total nonmethane VOCs
- MET for source identification
- Solar powered and cell data transmission

Cost

• \$750 to 1.5K to 15K

Detection limit

Low ppb to ppm

Accuracy

- ????
- Some you can calibrate some you can't





Low Cost VOC Sensor Networks

- Approach
 - Study 1 Parking lots study to evaluate if sensors could identify real time leaks
 - Study 2 Roof top study to evaluate data platform
 - Study 3 Live study on a well pad during drilling activities (in progress)





Low Cost VOC Sensor Networks – Study 1

- Release of a know quantity
 of VOC
- Acetone was the chosen VOC
 - Not a HAP
 - Exempt VOC
 - PID reacts well





Low Cost VOC Sensor Networks – Study 1



5:28 5:30 5:31 5:33 5:33 5:33 5:33 5:34 5:39 5:39 5:40 5:40

5:45

- Sensors worked at 500' goal with reasonable leak rates
- Zero drift of ~30 ppb
- Good agreement with paired sensors
- More sensor up time the better!



-Sensor #3

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0.18

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0.12

0.1

0.08

0.06

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0.02

Pasadena Refining System, Inc.

















- Incorporate all manners of sensors
- Incorporate fixed and mobile sensors
- Perform real time Quality Control on data (e.g. min/max, sticking, etc.)
- Reporting functions

 (averages, QA summary, daily e-mail summaries, monthly reports generation)
- Provide real time alerts via text and/or e-mail
- Mobile app





VOC Sensor Networks – Study 3, Part 1

- New well being drilled and fracked
- 2 PID Sensors
 - Continuous
 - IonScience PID w/hydrophobic filter
 - Periodic calibration
- 5 MOX Sensors
 - Data every 15 minutes
 - No calibration
- Adjustments to Data Platform

VOC Sensor Locations

NW Sensor (40.6120140, -104.8445359)
NE Sensor (40.6120230, -104.8431291)
SE Sensor (40.6105846, -104.8431009)
E Sensor (40.6113996, -104.8426124)
SW Sensor (40.6105671, -104.8445420)

New Well Location (Approx.)



















4/8/19 Calibrations







VOC Sensor Networks

Conclusions and findings

- MOX had diurnal patterns
- Data capture on the two PIDs was 29% and 71% (data com big issue)
- Lost data due to no local storage
- Question if we missed events with every 15 minute data transmission
- Manufacturers made changes to both sensors



VOC Sensor Networks

Next Steps

- Notes incorporated into platform
- Incorporate source identification algorithm into main platform
- Define alert thresholds (1 ppm for how long?) operators could be overrun with alerts!
- Local storage on sensors
- Evaluate more sensors! (Clarity added)
- Site 2 identified with 8 sensors (2 simultaneous studies)



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